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Pre-Qualification of the Michigan Technology

2019. 04

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MICHIGAN TECHNOLOGY

(주)미시간기술

Contents

1.1 History

1) History of the Michigan Technology

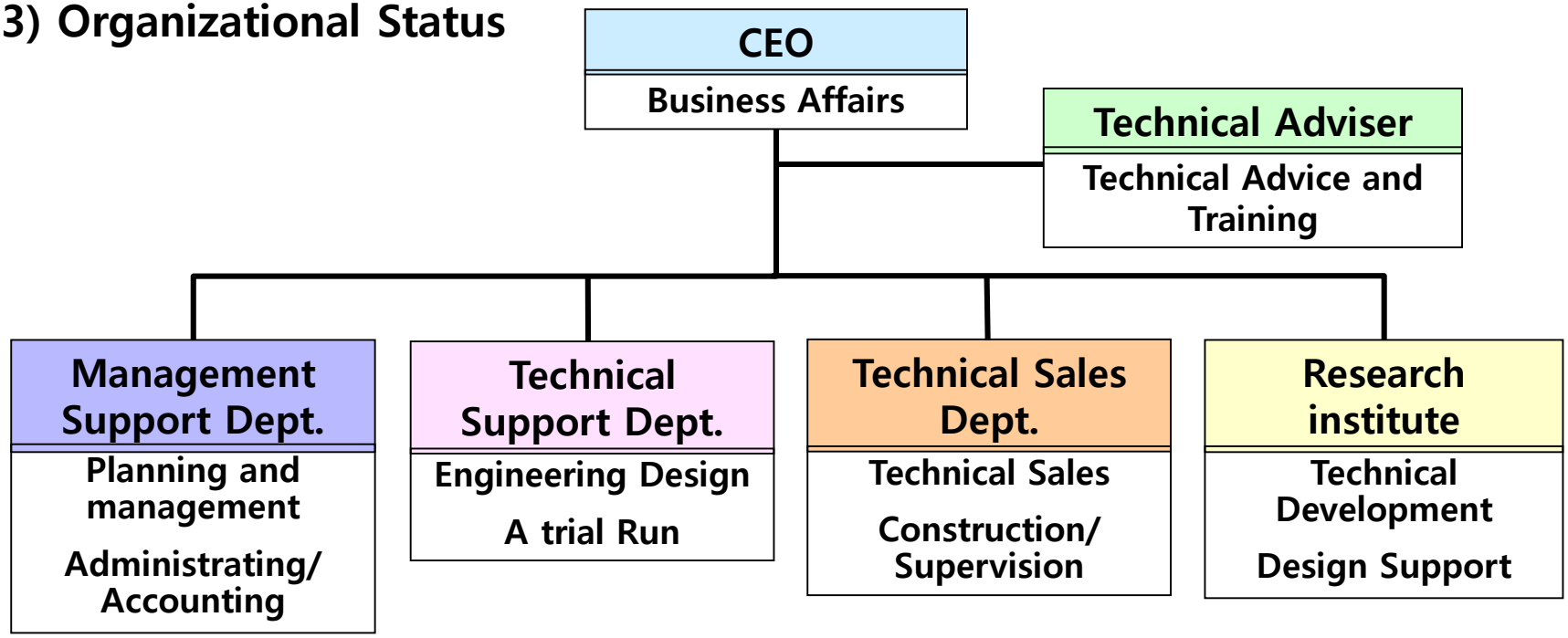
Date	History
2002.03	Michigan Technology Founded
2002.05	Firm Registration for Equipment Supply and Construction on Water and Wastewater Treatment (a registration number : Ulsan Namgu 2002-13-02)
2004.08	Registration for Specialized Construction Work on Water Distribution System and Water Supply (a registration number : No. 222)
2005.10	Developed an advanced treatment process for effluent discharged from wastewater treatment plants using “Dissolved Ozone Floatation (DOF™, Process)” designated No. 143 of New Environmental Technology, and No. 85 of Verified New Environmental Technology from Ministry of Environment, Korea
2006.06	Certified on a venture capital business (No. 061235035-1-00167)
2007.08	Founded R&D Center of the Michigan Technology (No. 20074348)
2008.01	Certified on an INNO-BIZ enterprise (No. 7024-4693)
2011.11	New CEO : Kang, Han Won was inaugurated as a president
2012.04	Registration for Construction work on Wastewater Treatment Systems (a registration number. : No. 10)

1.2 Technology and **Organization Chart**

2) Intellectual Properties

Classification	New technologies	Registered domestic patents	Pending domestic Patents	Registered foreign patents	foreign patent pending
Number	2 (New Environment Technology)	9	2	1	-

3) Organizational Status



2 Core technologies for water treatment

What Michigan Technology Does?

1. Drinking Water Treatment Using Ozone Technology
2. Domestic Wastewater Treatment for Water Reuse
3. Industrial Wastewater Treatment
4. Livestock Wastewater Treatment

What Technologies the Michigan Technology Have?

1. DAF (Dissolved Air Floatation)
   for SS, algae, VOCs, Oils
2. DOF (Dissolved Ozone Floatation)
   for COD, BOD, color, microbes, taste and odor, NBDOM, etc.
3. MBR with Ozone
   for Domestic and Industrial Wastewater Treatment

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2.1 MIDAF

❑ Overview of DAF(Dissolved Air Flotation)

The Dissolved Air Flotation (DAF) process is very effective in removing low density floc particles

for **drinking water** treatment. It is especially well known in removing turbidity and algae by

flotation process. The micro-bubbles in the DAF process pick up small flocs, thereby turbidity

materials and floated algae are removed efficiently.

DAF is widely applied in influent and effluent of wastewater treatments. DAF has been also widely used for phosphorus removal of biological wastewater treatment plants in 4 big river projects in Korea.

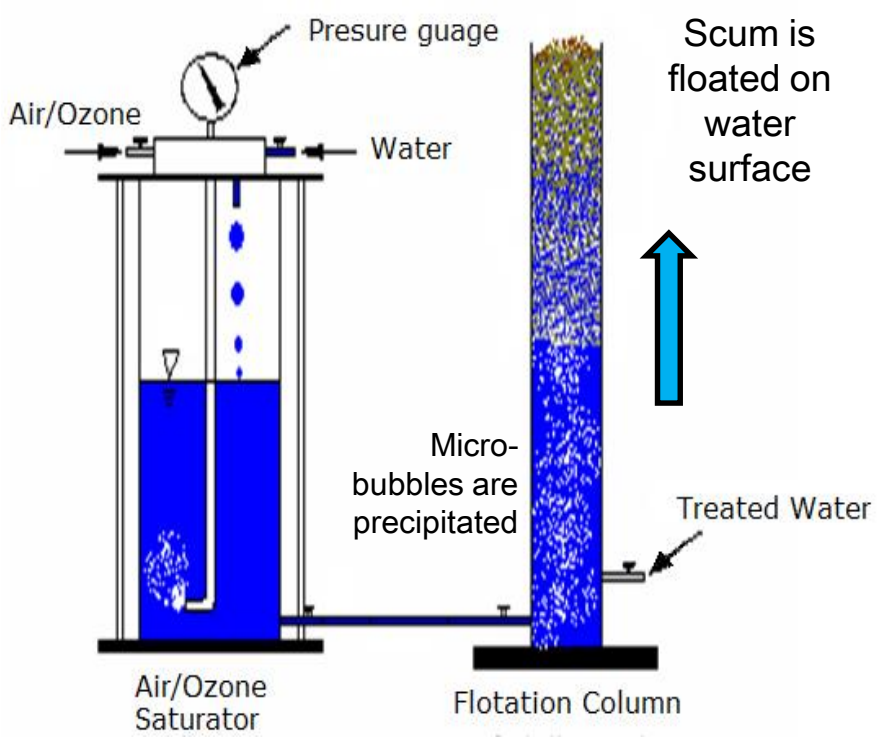
2.1 MIDAF

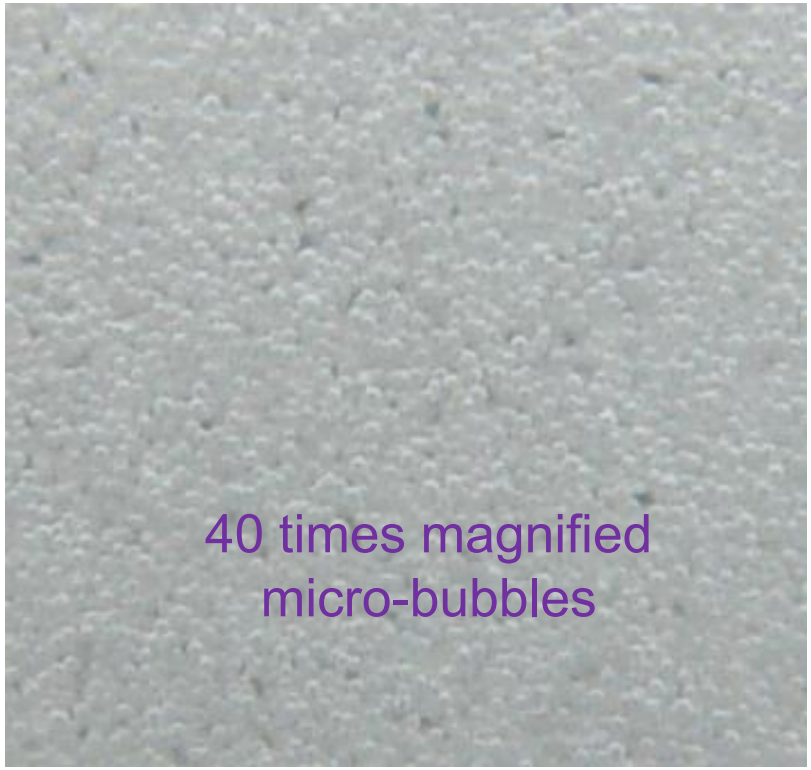
❑ Advantage of DAF(Dissolved Air Flotation)

- Shorter coalition period demanding smaller area for coagulation basin.
- Excellent system for advanced treatment of wastewater treatment plant for removal of SS, T-P, BOD, and COD.
- Higher water surface load rate providing higher flow rate with smaller area.
- Securing good water quality in relatively short period, and allowing fast recovery to normal operation.
- Excellent algae removal efficiency.
- Effective in removal of detergent, oil and heavy metallic particulate, and efficient removal of odor and volatile organic compounds(VOCs).
- Efficient removal of Tri-halo-methane formation potential(THMFP).
- Floated sludge obtained from DAF has lower water content than that of sedimentation sludge

❑ Basic Theory of DAF/DOF

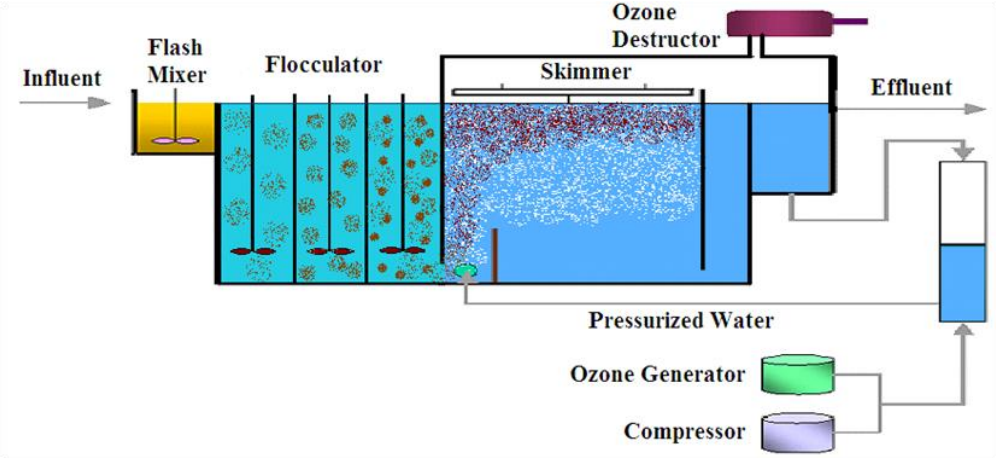
Air/Ozone is compressed in a confined container along with water. Air/ozone is dissolved in water, then air/ozone becomes liquid. If over saturated water by air/ozone is released under the atmospheric pressure, numerous micro-bubbles are precipitated. Micro-bubbles take flocs, SS, and algae, etc. on water surface





2 Core technologies for water treatments

2.1 MIDAF



Coagulation/ Flocculation bath

- Function : Stirring the coagulant and forming floc.
- Feature : Blending coagulant with influent.
  Forming floc of colloids and suspended solids.

Floatation bath

- Function : Removal efficiency of T-P/floating materials through generation of micro-air bubbles.
- Feature : A reaction between the pressurized water and raw water formed floc-air bubble aggregates by micro-bubbles
  Removal of floated sludge

Air dissolving system

- Function : A formation of pressurized water by dissolved air and water under high-pressure.
- Feature : Dissolving air in water under pressure.
  Control of air volume by regulating a pressurizing tank

2 Core technologies for water treatments

2.1 MIDAF

Technological features

- Application: To remove SS(suspended solids) by applying DAF to the secondary sedimentation basin
- Enhancement the existing facilities: Enhancement of filter performance
- Easy to start up
- Production of higher quality water, and DAF may be used with ozone for further higher quality of water for reuse

Cost effectiveness

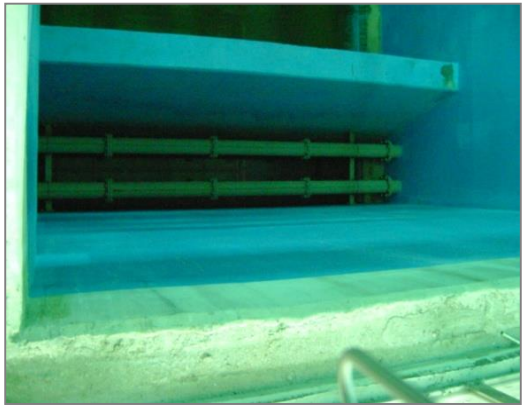
- Reduction of sludge disposal cost by low water content of floating sludge.
- DAF has no consumable parts to be replaced regularly
- Compact system: requiring minimum plant area by short residence time (40 minutes or less)
- Reduction of sludge dewatering power cost

Ease of Maintenance

- Simple process : coagulation and floatation is done in a process.
- No filter clogging or backwashing
- Stable operation even in fluctuating loading condition
- Rich Experiences: Many DOF systems in operation, under construction, being designed
- A prompt A/S

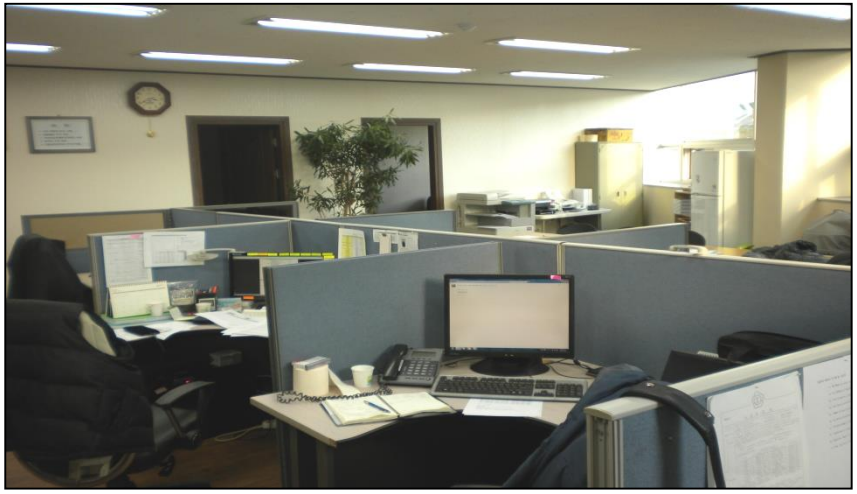
2 Core technologies for water treatment

2.1 MIDAF

classification	Ozone dissolving tank	Floated sludge removal device	Micro-bubble generator
Installed Parts			
Function And Characteristics	▪ Producing pressurized water with saturation percentage (98%) ▪ Control of bubble-generation which being connected with micro-bubble generator ▪ Regulate ozone solubility by controlling pressure and ozone dose ▪ Connected to a compressing system which enables to compress highly corrosive gases like ozone	▪ Remove floated sludge ▪ Stable operation of skimmer ▪ Skimmer is completely sealed preventing leaking of ozone ▪ Movement velocity of skimmer may be controlled depending on influent water quality and floated sludge conditions ▪ Low energy consumption by moving with wheels	▪ Generate micro-bubbles with the pressurized water ▪ Generated micro-bubbles combine with flocs without disturbance ▪Generate uniform micro-bubbles without generating macro-bubbles ▪ Micro-bubble generator is a permanent part which no need to replace

2.1 MIDAF

Professional Personals are Educated in R&D Institute



- Personals possessing Ph. D and MS degree Lead the Institute
- Research Contents
  - Critical Weight Affecting Removal Mechanism in DAF (Excellent paper awards)
  - Baffle effect in DAF (Dissolved Air Flotation) performances
  - Flow pattern in flotation tank affecting in DAF performance

Leading Technologies are Developed and Innovated through Lab System

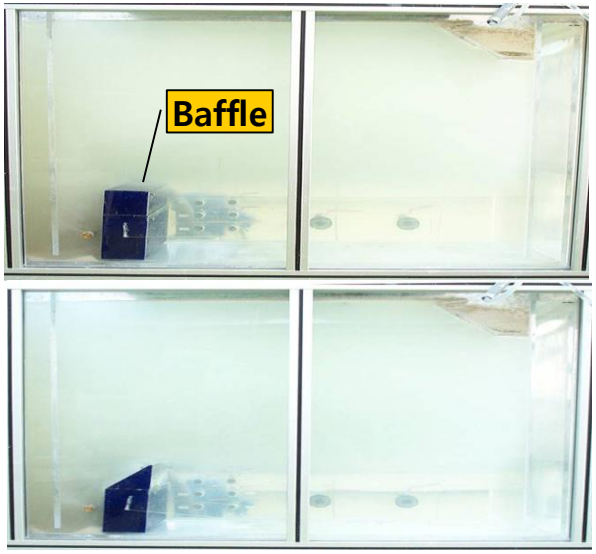
- Design parameters like retention time and size of orifice are decided through pilot test
- Height and angle of baffle in flotation tank are designed minimizing dead space.
- Optimum design is done by rich design and operation experiences

2.1 MIDAF

Investigation of Bubble Layer Formation

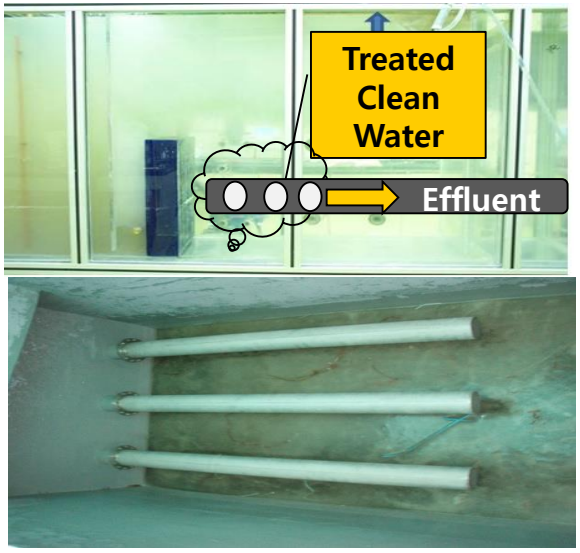
•Micro bubbles generated in Michigan Technology are small and uniform, rising velocity is slow to provide longer contact period with flocs.
•Compact bubble layer preventing flocs from sinking on the bottom of flotation tank

Investigation of Baffle Shape



• Even though contact efficiency between flocs and micro-bubbles is enhanced when baffle is high, bubble layer is formed thin, and rising velocity of flow becomes higher, which deteriorate effluent water quality

Drain Collector Application



•Separated water (Treated water) from flocs is formed under the bubble layer

•Drain collector pipes are installed under the bubble layer to obtain highest quality of water

2.1 MIDAF Process

Results of operation of the H Domestic Wastewater Treatment Plant

	Raw Water	Effluent	Removal Rate (%)
BOD (mg/L)	9.4	3.8	59.6
COD (mg/L)	19.6	8.3	57.7
SS (mg/L)	5.7	2.3	59.6
T-N (mg/L)	6.1	5.3	13.1
T-P (mg/L)	0.72	0.1	86.1
Turbidity (NTU)	2.5	1.2	52.0
Color (CU)	26	15	42.3
UV-254 (ABS)	0.157	0.126	19.7

2.1 MIDAF Process

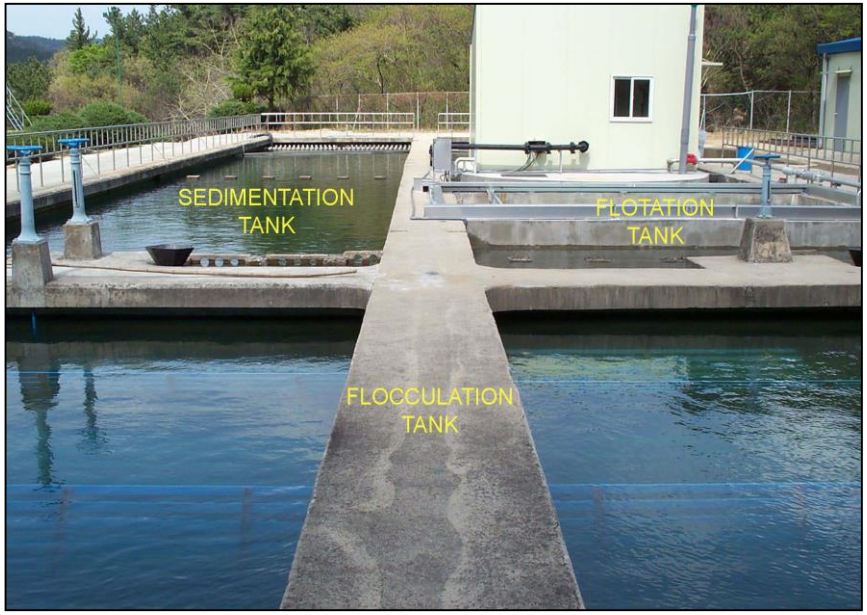
Results of operation of the H Water Treatment Plant

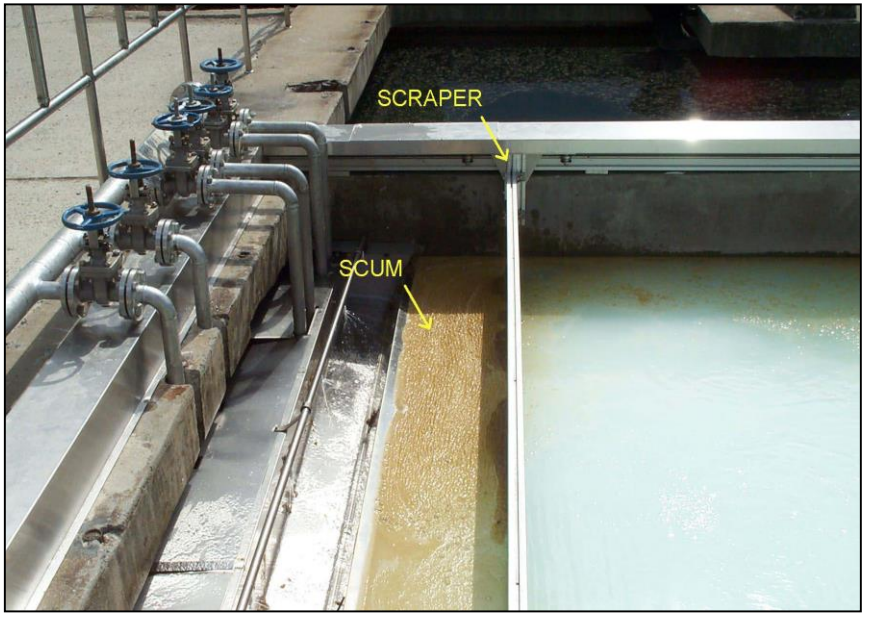
	RAW water	MIDAF	
		Effluent	Removal Rate (%)
Turbidity (NTU)	3.84	0.47	87.7
SS (mg/L)	5.11	1.5	70.6
Color (CU)	11.5	2	82.6
$KMnO_4$ (mg/L)	10.01	4.74	52.6
UV-254	0.069	0.044	36.2
Chlorophll-a (μg/L)	21.62	1.49	93.1

2.1 MIDAF Process

❑ Comparison of MIDAF and Sedimentation [Bangeojin water treatment Plant of Ulsan City]

Renovation of sedimentation basin to DAF System





Sedimentation Basin (Left Side)–Renovated MIDAF system (Right Side)

< Renovation of Sedimentation Basin to MIDAF System> <Micro-bubbles of MIDAF and removal of floated sludge >

2.1 MIDAF Process

❑ Comparison of MIDAF and Sedimentation [Bangeojin water treatment Plant of Ulsan City]

Sedimentation Basin (Left Side)–Renovated MIDAF system (Right Side)

Renovated MIDAF system (Left Side)–Sedimentation Basin (Right Side)

< Refloated sludge of Sedimentation Basin (Left Side) >

< Water Quality Deteriorated by Refloating Sludge>

2.2 DOF Process

❑DOF (Dissolved Ozone Flotation) System

DOF = DAF + Ozone

Excellent Separation	Strong Oxidation
Removal of SS, Turbidity	Disinfection of Virus, Bacteria
T-P	Removal of Color, Odor, Taste
Algae	Removal of BOD, COD,
Oil, Surfactant, etc.	Hazardous Materials

DOF can do all this in One Unit

2.2 DOF (Dissolved Ozone Flotation) Process

(1) Overview of technologies

- DOF system is the combined technology of DAF and Ozone oxidation
- Organic materials, phosphorus, color, and turbidity are removed by flotation.
- Microbes (e.g., coliform bacteria and heterotrophic bacteria), color, taste and odor, UV254 absorbance are removed by ozone oxidation
- Micro-bubbles are generated under the pressure of 4 to 6 kgf/cm2
- No. 143 of New Environmental Technology, and No. 85 of Verified Environmental Technology from the Korean Ministry of Environment.

2.2 DOF (Dissolved Ozone Flotation) Process

(2) Advantages of DOF technology

- Various application scope, high treatment efficiency, and highly specialized applications compared to conventional processes of filtration, membrane separation, or UV disinfection.
- Lower construction cost by higher ozone utilization rate (over 96%) than conventional ozone facility.
- High quality of water production for reuse by removing COD, BOD, color, odor, and microbial agents.
- Discharging effluent of DOF system enhancing receiving water by increasing DO, and by removing phosphorus.
- Off-gas of DOF can be used for supplying oxygen in biological wastewater treatment.

2.2 DOF (Dissolved Ozone Flotation) Process

❑ Applications of DOF Process

- Drinking water treatment
- Advanced wastewater treatment : tertiary treatment.
- Used in Water recycling process.
- Removal of color of dye or pigment industry, and COD of industrial waste water or poultry wastewater.
- Advanced treatment of biological wastewater effluent.
- Removal of taste and odor material, color, and other micro-pollutants in **drinking water** treatment.

2.2 DOF System

DOF can be Used in both for Drinking Water and Wastewater Treatments

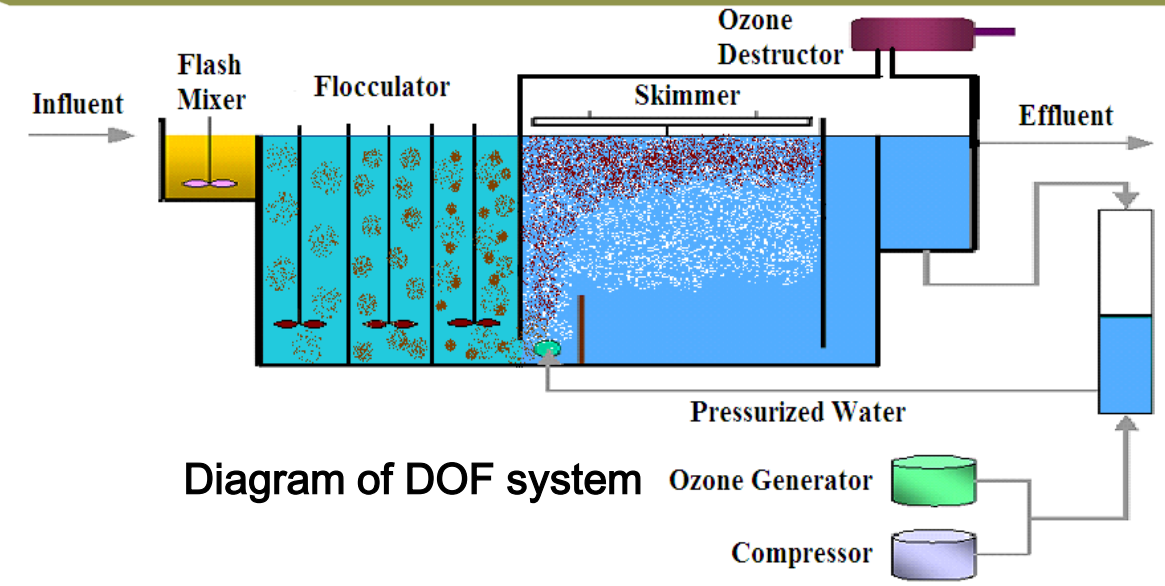


Diagram of DOF system

DAF and DOF are alternatively operated depending on influent water quality. When influent quality is good enough, the system can be used as DAF using air only.
Otherwise influent quality is not good enough, the system can be used as DOF using ozone to give higher water quality.

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2 Core technologies for water treatment

Small Scale of the DOF Plant (200m3/day)

Operating Cost : about 5 UScents/m3


Front Side


Back Side

Size : 2m x 1.5m x 2.5m (May be carried inside Container Box)
Drinking Water : may supply to 1000people

2.2 DOF System

❑ DOF process treatment efficiency in wastewater treatment (Ozone 7.6ppm, Recycle rate 15%)

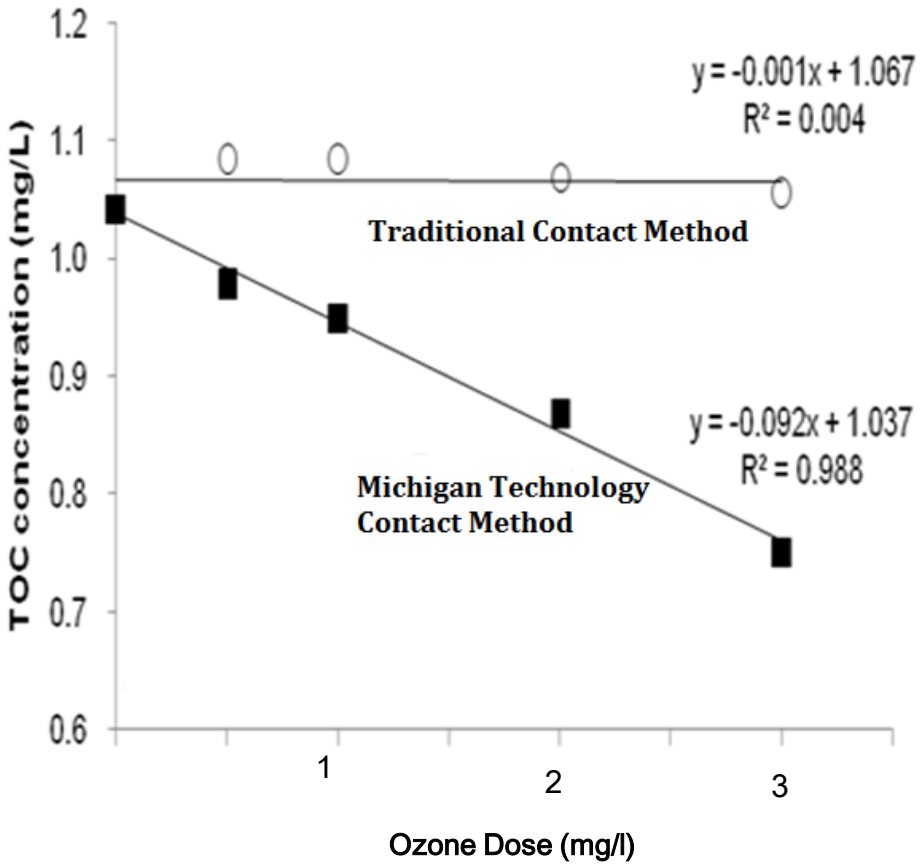
	Raw Water	Effluent
Temperature (℃)	22.8	22.4
pH	6.98	6.86
DO (㎎/ℓ)	5.4	10.5
UV-254 (ABS)	0.116	0.043
Color (CU)	26.9	7.2
Turbidity (NTU)	11.6	0.7
SS (㎎/ℓ)	15.8	2.0
COD_{Mn} (㎎/ℓ)	10.2	4.5
BOD (㎎/ℓ)	4.1	2.0
T-N (㎎/ℓ)	7.25	4.2
T-P (㎎/ℓ)	0.63	0.05
Common bacteria (CFU/㎖)	TNTC	0
Coliform bacilli (MPN/㎖)	810	0

All bacteria are gone when we use Ozone

TNTC : Too Numerous To Count

2.2 DOF System

TOC Removal by ozone contact in Drinking Water Treatment



Removal of TOC by traditional ozone contact method was not enhanced by increasing ozone dose, while DOF could enhanced TOC removal which was proportional to ozone doses as shown the figure

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2.2 DOF System

◑ The results of Ozone consumption efficiency (validated in the new environmental technology)

< Ozone Utilization Rate >

	Min.	Max.	Avg.
Quantity of injected ozone (㎎/min)	648	1,692	1,619
Quantity of discharged ozone(㎎/min)	3.4	133.2	35.6
contact efficiency(%)	92.1	99.7	97.0

< Ozone concentration of the treated water >

	Min.	Max.	Avg.
Concentration of injected ozone (㎎/ℓ)	14.2	36.3	24.9
Ozone concentration of the treated water (㎎/ℓ)	0.01	1.12	0.63

2.3 PO3 System

❑ Overview of PO3 (Pressurized Ozone Oxidation)

Higher concentration of ozone provides higher oxidation potential, and higher removal rates of various refractory material in wastewater.

High concentration of ozone is introduced into raw water under high pressure of ozone gas.

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❑ Advantages of PO3 Process

- Short retention time
- Excellent removal capability of organic material.
- Excellent color removal
- Low construction and maintenance cost
- No sludge produced

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2.3 PO3 System

❑ Applications of PO3 Process

- Treatment of refractory organic materials and/or highly colored wastewater
- Advanced wastewater treatment for water reuse
- Treatment of industrial/livestock wastewater, and leachate
- Renovation of ozone contact system in drinking water treatment
- Treatment of concentrate produced in RO system operation

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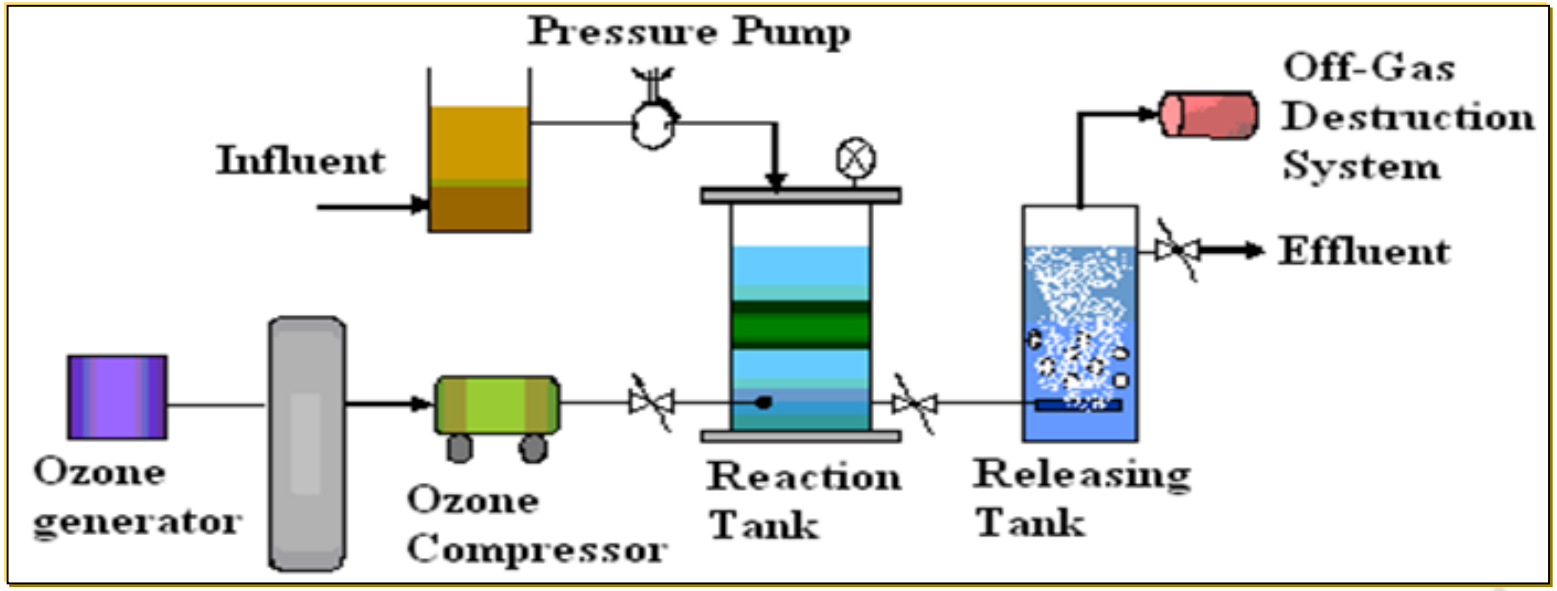
2.3 PO3 System

Pressurized Ozone Oxidation Process



PO3 system can be used when influent does **not** contain suspended solids (SS)

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2.3 PO3 System

PO3 PLANT Application: Pusan dyeing industry wastewater treatment plant

(Comparison of treated color depending on applied ozone concentrations)

Secondary sedimentation effluent 498(CU)

5ppm Contact 150(CU)

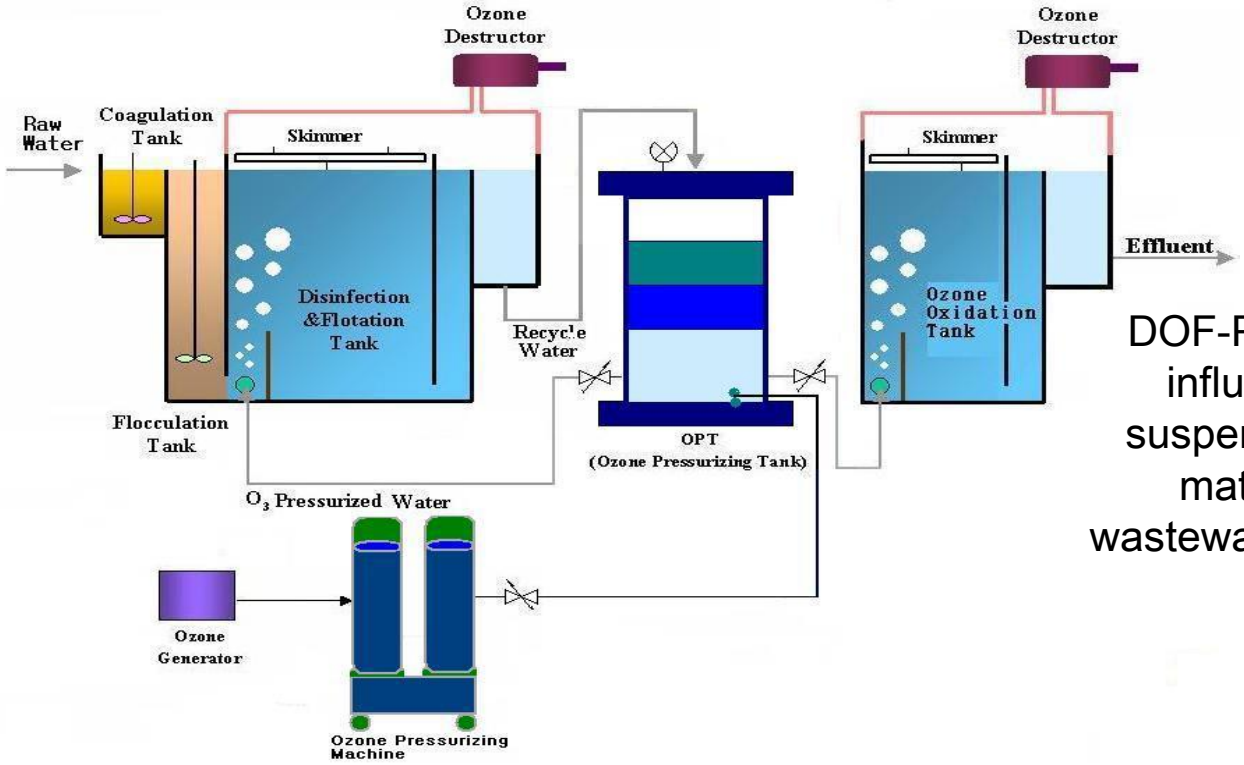
6ppm Contact 112(CU)

8ppm Contact 72(CU)

14ppm Contact 35(CU)

2.4 DOF-PO3 System

DOF-PO3 Process



DOF-PO3 process is used when influent (raw water) contains suspended solids, and refractory materials such as livestock wastewater, or industrial wastewater

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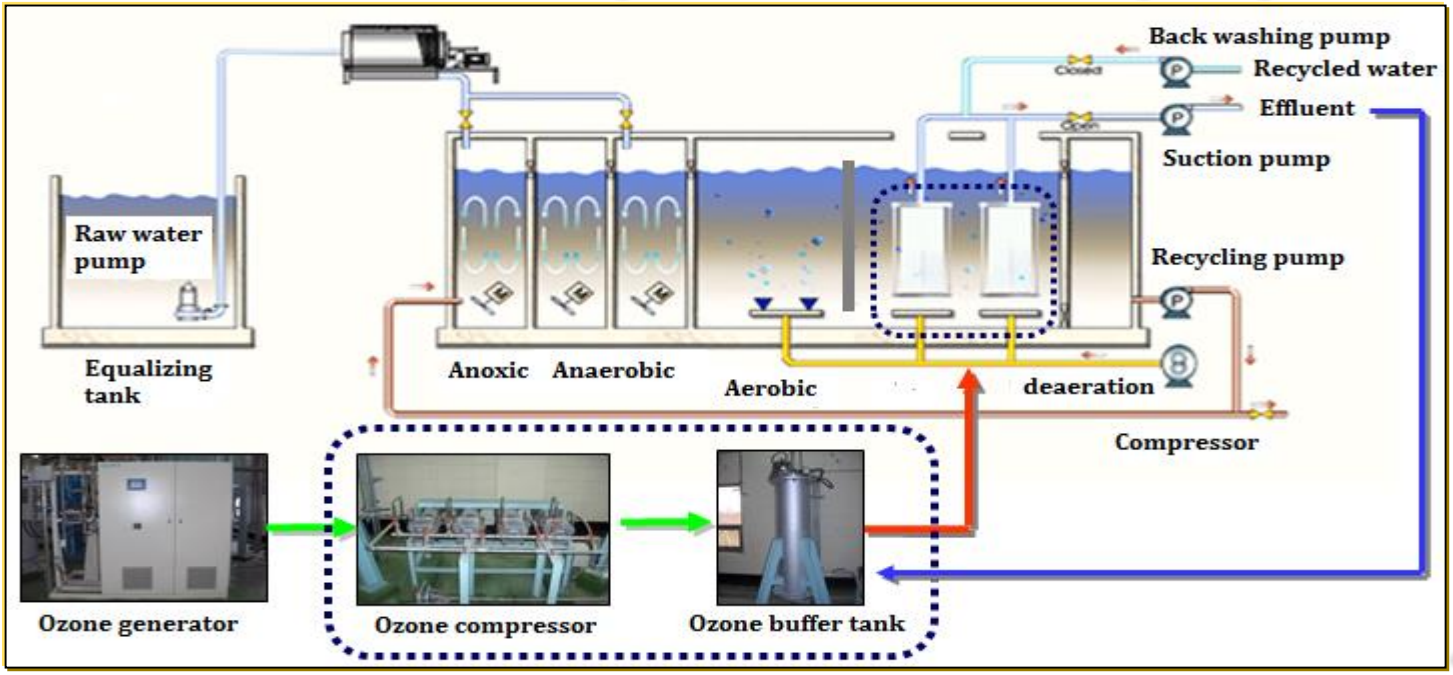
2.5 Additional Technology

MBR Process with Preventing Membrane from Fouling using Ozone



- Ozone-pressurized water generated and introduced into Aerobic Tank
- Membrane fouling reduction technology by ozone micro-bubble
- Enhancement of removal rate of organic material in MBR (Membrane Bioreactor) by Ozone.

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3.1 Drinking Water Treatment Using DOF system

- ❑ Water Supply in Small Scale Villages (1,000~2,000 people)
- ❑ Drinking Water Treatment in a Building or an Apartment
- ❑ Large Scales of Drinking Water Treatment
- ❑ Removal of Algae in Drinking Water Treatment Process

3.2 Wastewater Water Treatment Using DOF system

- ❑ Wastewater Treatment in Small Scales
- ❑ Wastewater Treatment in a Building or an Apartment for reuse
- ❑ Large Scales of Domestic Wastewater Treatment for reuse
- ❑ Removal of SS, Phosphorus, BOD, COD, Color, and Odor in Wastewater Treatment Process

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4 Intellectual property of the Michigan Technology

❑ New Environmental Technologies, and Verified Environmental Technologies by the Government

classification	Appraisal	Patentee	Title	Registration number
Ministry of Environment	Korea Environment Management Corporation	Michigan Technology	Advanced treatment process of secondary wastewater effluent Using coagulation and flocculation, and dissolved ozone floatation (DOF Process)	No. 143 of New Environmental Technology No. 85 of Verified Environmental Technologies

❑ Intellectual property rights of the company

classification	Registration number	Patentee	Title	Date
Korean Patents	No.0321799	Michigan Technology	Water treatment method and system employing electrical coagulation and dissolved air floatation	2002.01.10
	No.0321800	Michigan Technology	Water purification method employing dissolved air floatation (DAF)	2002.01.10
	No.0702198	Michigan Technology	Oxidative gas-pressurizing system	2007.03.26
	No.0710488	Michigan Technology	Wastewater treatment system and method employing dissolved ozone floatation (DOF) and pressurized ozone oxidation method associated with biological wastewater treatment	2007.04.16
	No.0754526	Michigan Technology	Wastewater treatment method and system using composite oxidation methods	2007.08.27
	No.0848117	Michigan Technology	Hybrid water treatment system	2008.07.17
	No.1023037	Michigan Technology	Pressurizing system of highly corrosive (oxidative) gases	2011.03.10
	No.1069773	Michigan Technology	Wastewater treatment system and method using separation membrane bioreactor	2011.09.27
	No.1130342	Michigan Technology	Apparatus removing floating and sedimented sludge	2011.03.19

5 Records of applications (References)

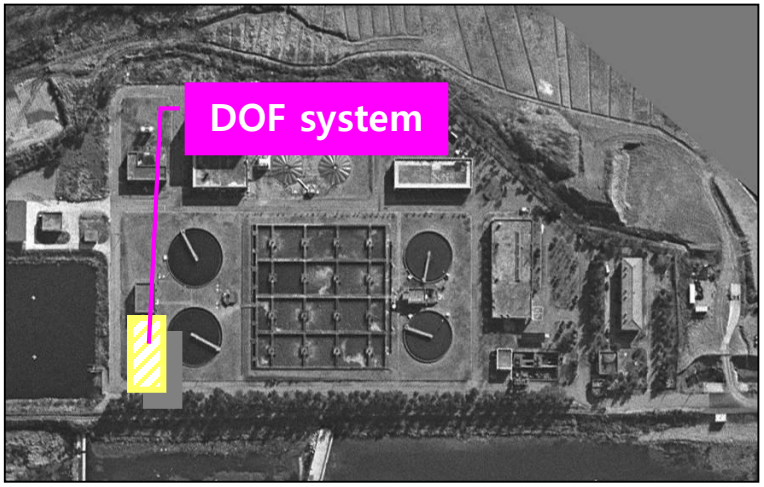
classification	Description	Status	Facility capacity
Drinking water	Renovation of Sedimentation Basin in Bangeojin Water Treatment Plant of Ulsan City (MIDAF)	Under operation	6,500 tons/day
Domestic wastewater	Advanced Treatment Plant at Hweya in Ulsan City (combo DAF/DOF)	Under operation	32,000 tons/day
	Advanced Treatment Plant at Hwayang in Cheondo (DOF)	Under operation	7,600 tons/day
	Advanced Wastewater Treatment Plant for Reuse at Cheongbuk in Pyeongtaek (DOF)	Under operation	2,700 tons/day
	Advanced Wastewater Treatment Plant at Munsan in Jinju (DAF)	Under operation	7,400 tons/day
	Advanced Wastewater Treatment Plant at Sabong in Jinju (DAF)	Under operation	2,500 tons/day
	Advanced Wastewater Treatment Plant at Undong in Busan New Port	Under construction	8,000 tons/day
Livestock night-soil wastewater	Advanced treatment plant of public livestock night-soil wastewater in Pocheon City (DOF)	Under operation	170 tons/day
	Advanced treatment plant of public livestock night-soil wastewater in Boryeong City (DOF)	Under operation	120 tons/day
Industrial wastewater	Advanced wastewater treatment plant of industrial complex in Wolnong, Paju (DOF) : 1st plant	Under operation	9,000 tons/day
	Advanced Wastewater Treatment Plant in Jeongchon (MIDAF)	Under operation	2,250 tons/day
	Advanced Wastewater Treatment Plant in industrial complex in Wolnong, Paju (DOF) : 2nd plant	Under operation	8,000 tons/day

5.1 DOF Process

◐ Hweya Wastewater Treatment Plant (Ulsan City)

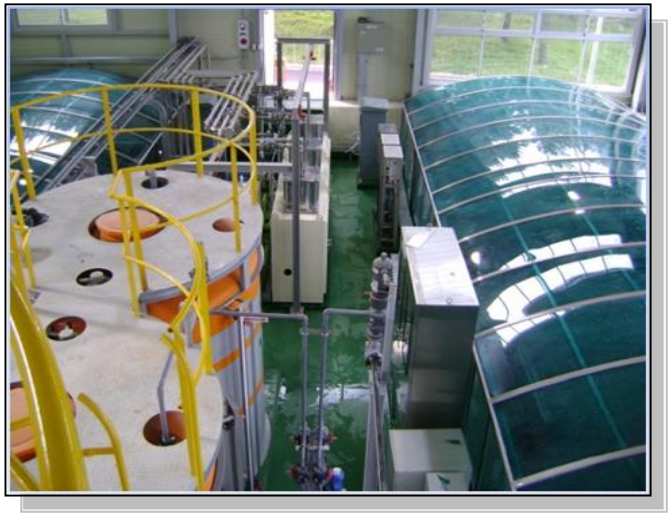
- Overview of the DOF system

▪ Construction : Advanced Tertiary Wastewater Treatment at Hweya Plant in Ulsan
▪ Facility capacity : 32,000 tons/day
▪ location : 808, Daedae-ri, Ungchon-myeon, Ulju-gun, Ulsan, Korea
▪ Status : Under Successful Operation



5 Records of applications (References)

5.1 DOF Systems



5.2 DOF-PO2 System

◐ Boryeong Livestock Waste Water Treatment Plant

- Project Overview

▪ Project Name : Advanced treatment plant of public livestock wastewater in Boryeong City

▪Facility capacity : 112 tons/day

▪ location : 890-3 ,Sinjuk-ri, Cheonbuk-myeon, Boryeong-si, Chungcheongnam-do, Korea

▪ Status : Under operation

< Raw water >

< DOF-PO2 treated water >

5.2 DOF-PO2 System

[Treatment efficiencies of Boryeong Livestock Wastewater]

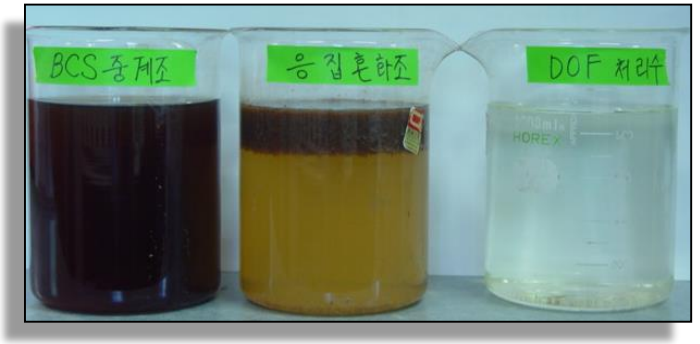
Item	Raw water (mg/L)	Treated water (mg/L)	Treatment efficiency (%)
COD_{Mn}	641	72	98.8
SS	411	10	97.6
T-P	126	49	61.1
color	755	38	95.0
Heterotrophic bacteria	TNTC	0	100.0

[Treatment efficiencies of Pocheon Livestock Wastewater]

Item	Raw water (mg/L)	Treated water (mg/L)	Treatment efficiency (%)
COD_{Mn}	619.9	63.0	89.8
SS	409	22	94.7
T-P	27	0.35	98.7
color	850	42	95.1
Heterotrophic bacteria	TNTC	0	100.0

[Results of operation of Boryeong Livestock Wastewater]

[Results of operation of Pocheon Livestock Wastewater]



5.3 DOF/DAF Systems

<Cheongdo(DOF) >

< Jeongchon(DAF) >

< Pyeongtaek(DOF) >

< Bangeojin Plant of Ulsan City(DAF) >

5.3 DOF/DAF Systems

Advanced wastewater treatment plant at Munsan in Jinju (DAF)

5.3 DOF/DAF Systems

Advanced wastewater treatment plant at Sabong in Jinju (DAF)

5.3 DOF/DAF Systems

Advanced industrial wastewater treatment plant of Wolnong Complex in Paju (DOF)

6 Prices

6.1 DOF/DAF smaller Systems

Cubic meter per day	Prices (FOB) US$
100	**150,000**
200	**160,000**
300	**170,000**
500	**195,000**

All these system can be mounted in one container

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